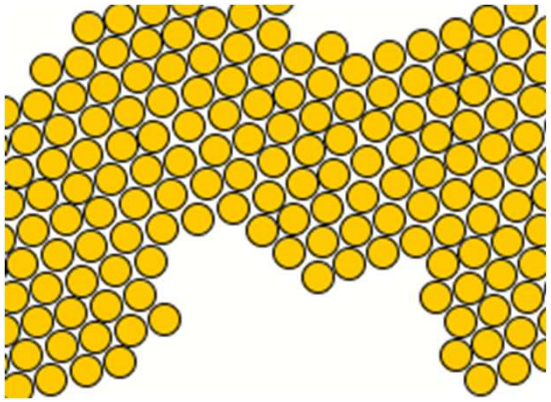
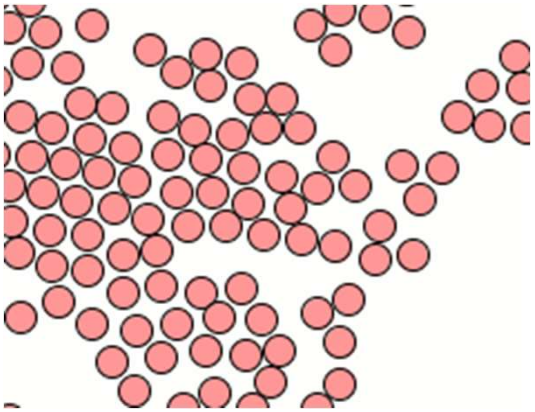
stati di aggregazione della materia

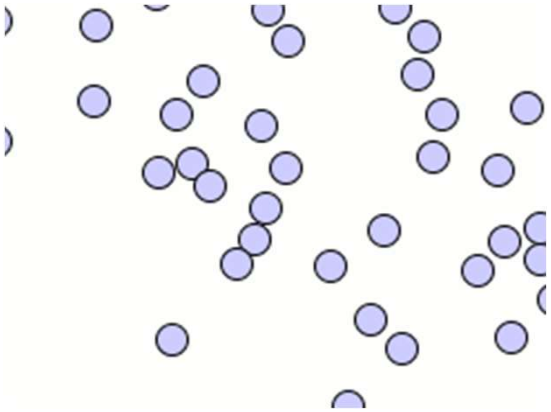
stato solido

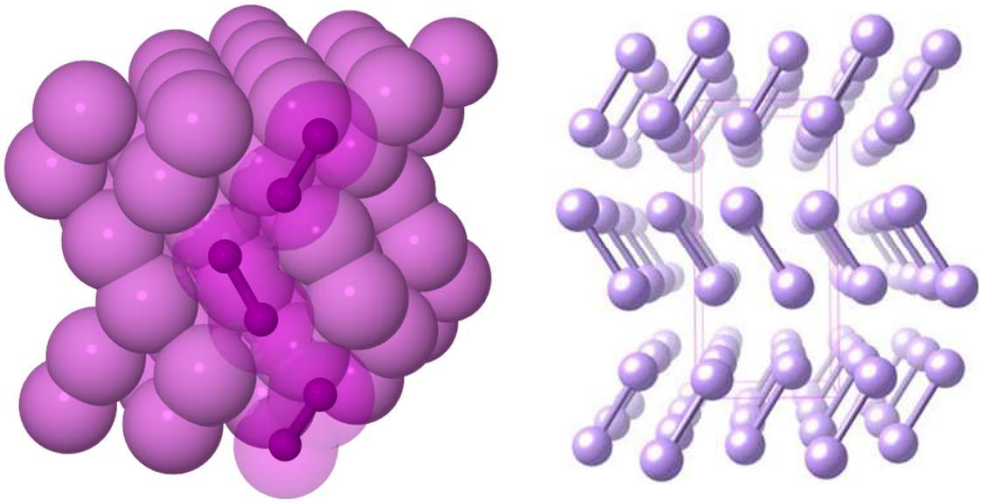


stato liquido



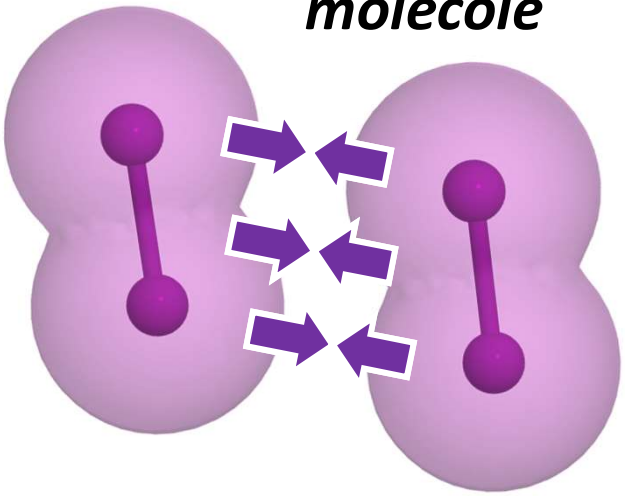
stato gassoso





iodio I_2 (solido)

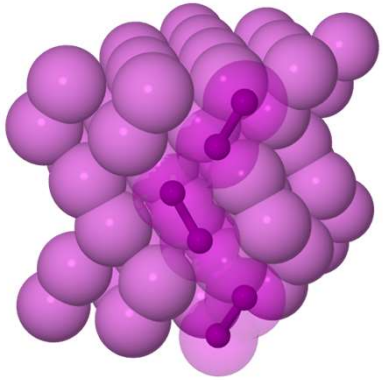
interazione tra ***molecole***



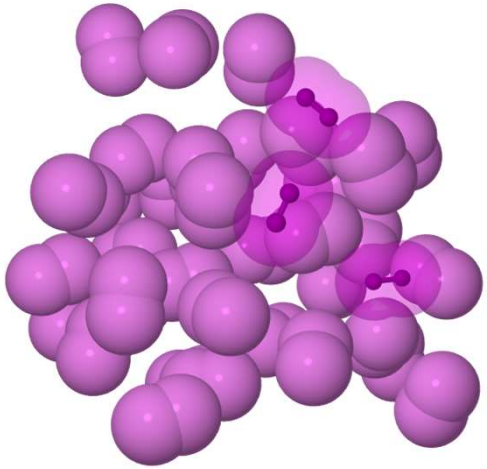
interazione tra ***atomi***

legame
covelente

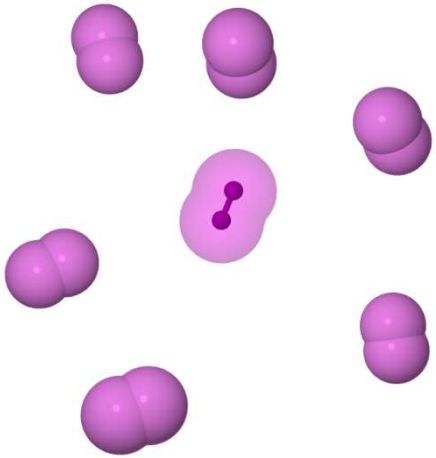
stati di aggregazione della materia



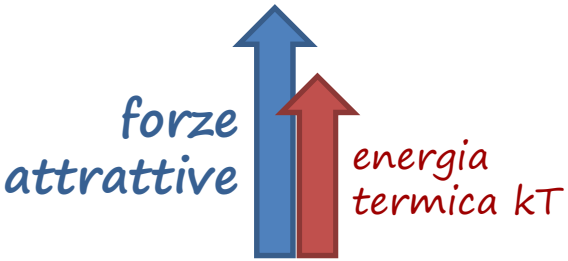
solido

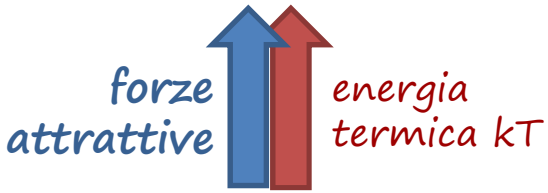


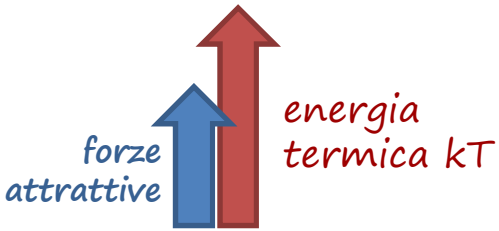
liquido



gas







forze intramolecolari

- si manifestano all'interno di una molecola (o insieme atomi/ioni)
- più forti *(150-4000 kJ/mol)*
- fortemente direzionali
- a corto raggio
- determinano le proprietà CHIMICHE della materia

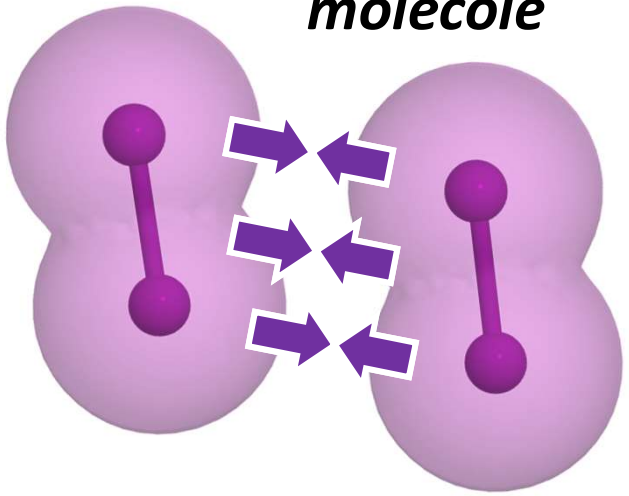
*interazione tra **atomi***

legame covelente

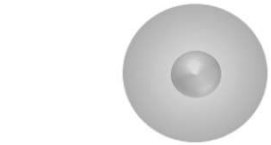
forze intermolecolari

- forze che si manifestano tra entità molecolari (uguali o diverse tra loro)
- più deboli *(0.05- 30 kJ/mol)*
- meno (non-) direzionali
- ad ampio raggio
- determinano le proprietà FISICHE della materia

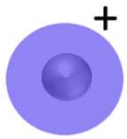
*interazione tra **molecole***



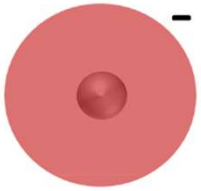
tipi di specie chimiche possibili



atomi neutri He

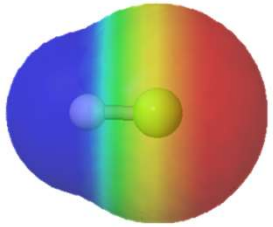


cationi Na^+



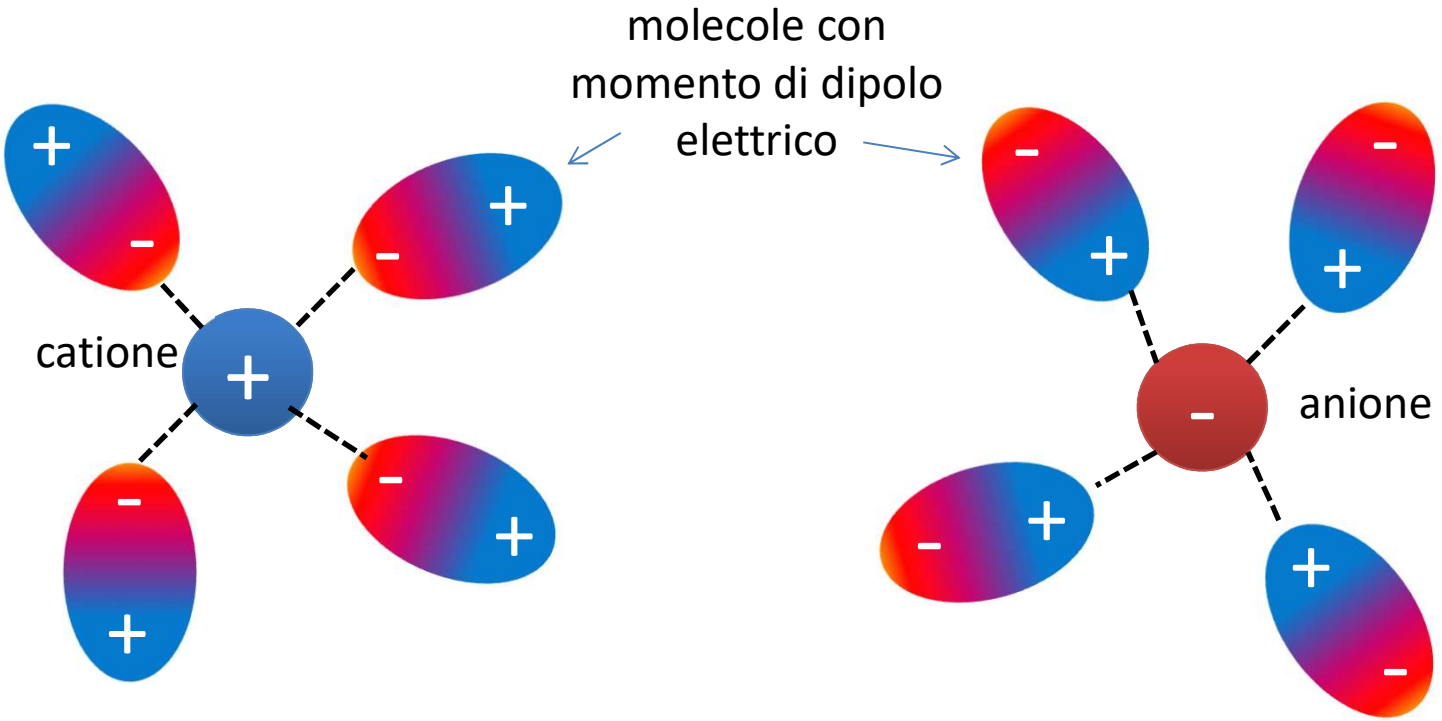
anioni Cl^-

molecole non-polari H-H

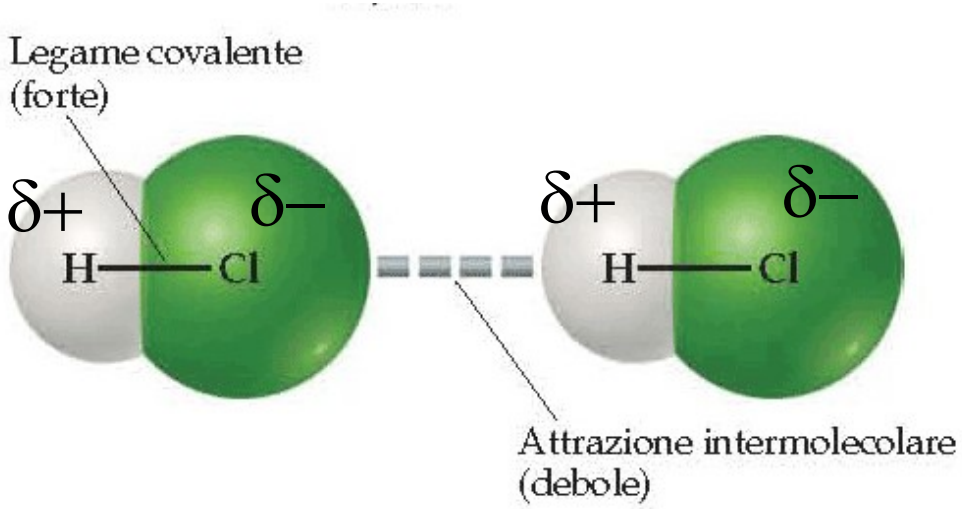


molecole polari H-F

interazioni ione-dipolo (40-600 kJ/mol)

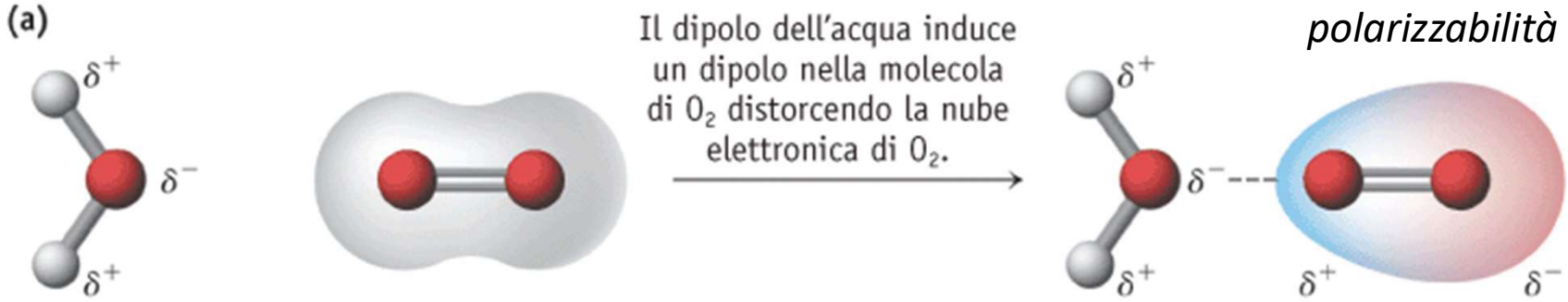


interazioni dipolo - dipolo (5-30 kJ/mol)



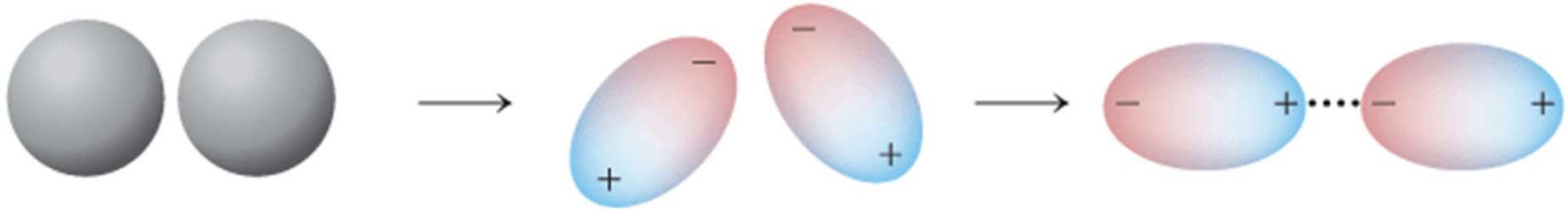
interazioni dipolo - dipolo indotto (2-10 kJ/mol)

concetto polarizzabilità



interazioni dipolo indotto - dipolo indotto (0.05-40 kJ/mol)

(forze di dispersione di London)



Due atomi o molecole non polari (rappresentate come se avessero una nuvola elettronica, mediata nel tempo, di forma sferica).

Le attrazioni e le repulsioni temporanee tra nuclei ed elettroni in molecole vicine producono dipoli indotti.

La correlazione tra i moti degli elettroni tra due atomi o molecole (che ora sono polari) produce un'energia minore e stabilizza il sistema.

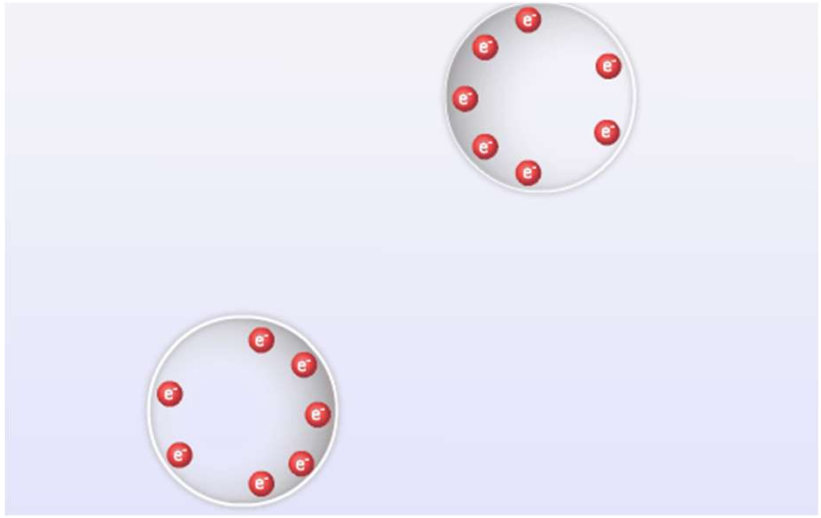


TABELLA 11.1 Punti di ebollizione di composti a 1 atm

Composto	Nome	Massa molare (g/mol)	Punto di ebollizione (°C)
F_2	Fluoro	38	–188.1
Cl_2	Cloro	71	–34.6
Br_2	Bromo	160	58.8
I_2	Iodio	254	184.4
CH_4	Metano	16	–164
C_2H_6	Etano	30	–88.6
C_4H_{10}	Butano	58	–0.5
C_6H_{14}	Esano	86	69
C_6H_{14}	2,2-Dimetil butano	86	50
C_6H_{14}	2,3-Dimetil butano	86	58

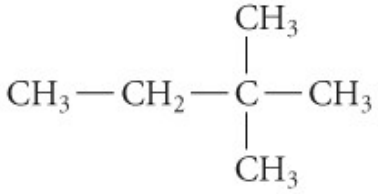
forze di dispersione di London

funzione di:

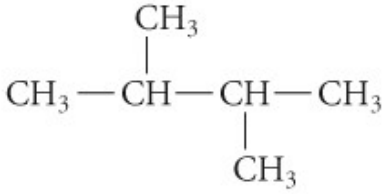
- massa molare
- forma

La molecola lineare di esano ha un punto di ebollizione più alto dei due isomeri, in cui alcuni degli elettroni polarizzabili sono "nascosti".

Esano
pe 68°C

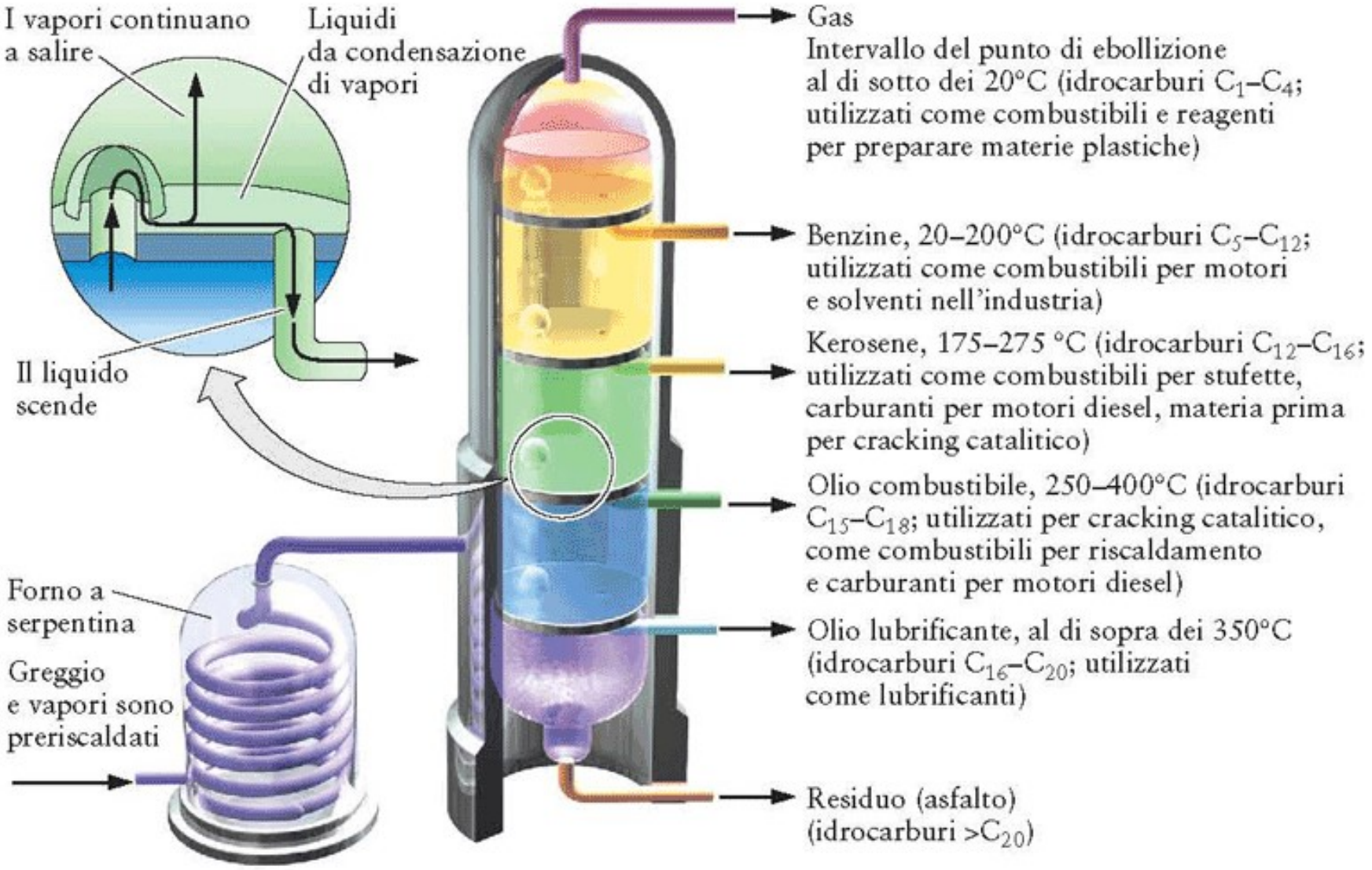


2,2-Dimetilbutano
pe 50°C

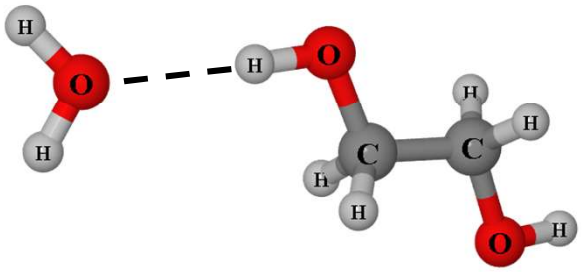


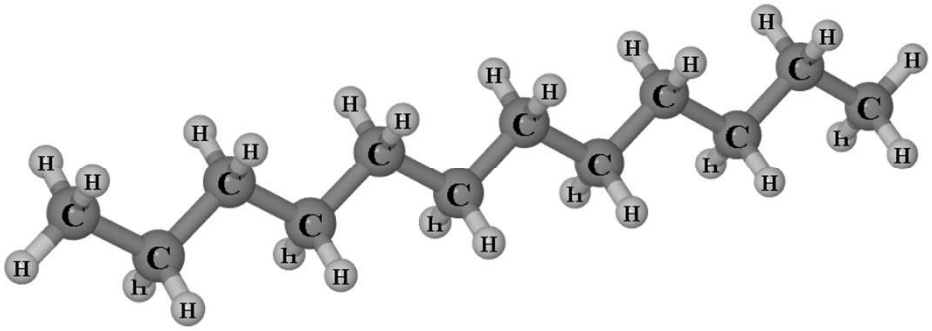
2,3-Dimetilbutano
pe 58°C

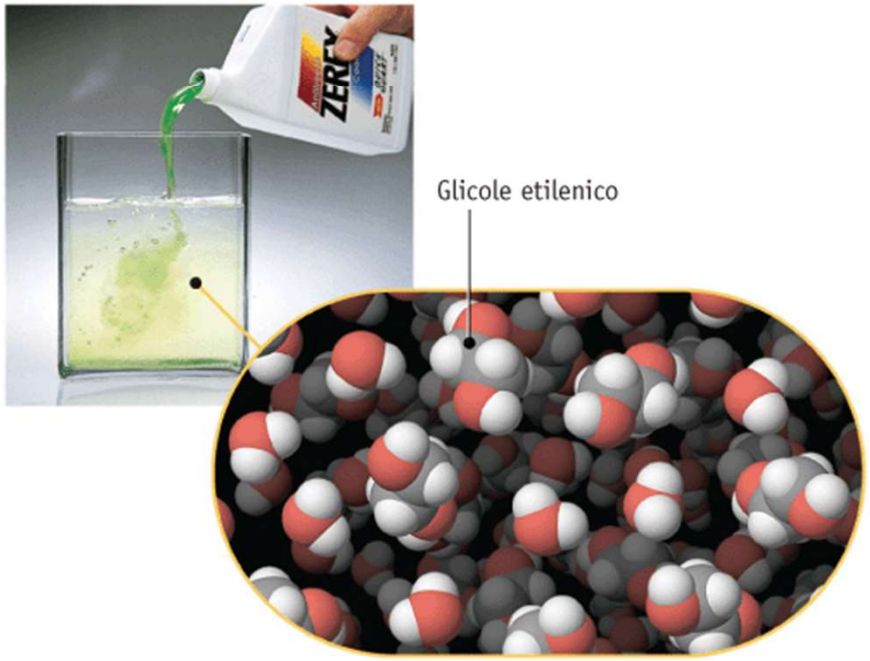
distillazione/raffinazione del petrolio



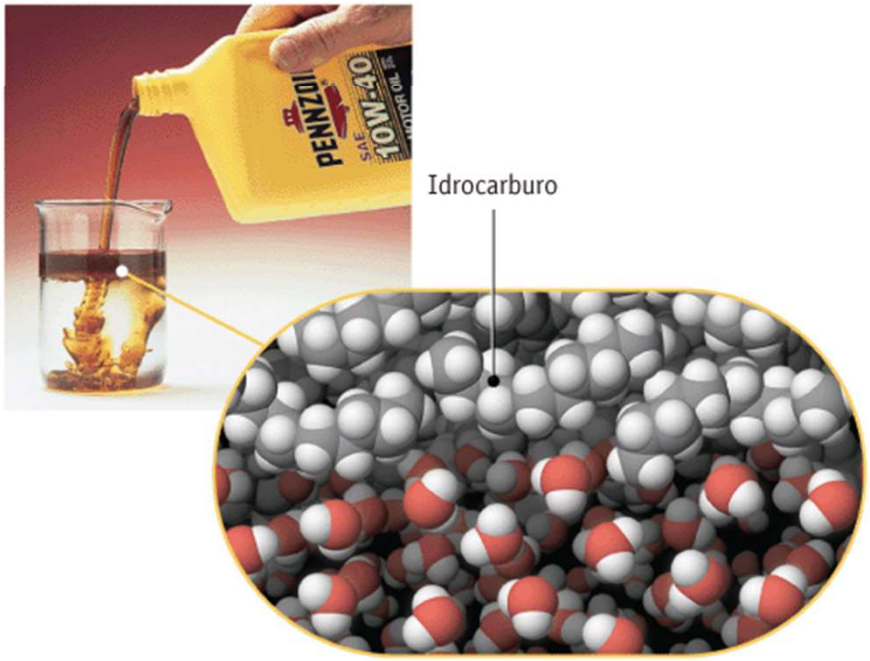
“similia similibus solvuntur” (il simile scioglie il simile)



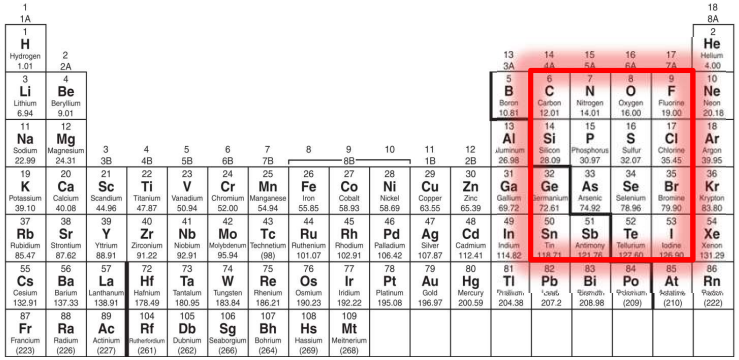


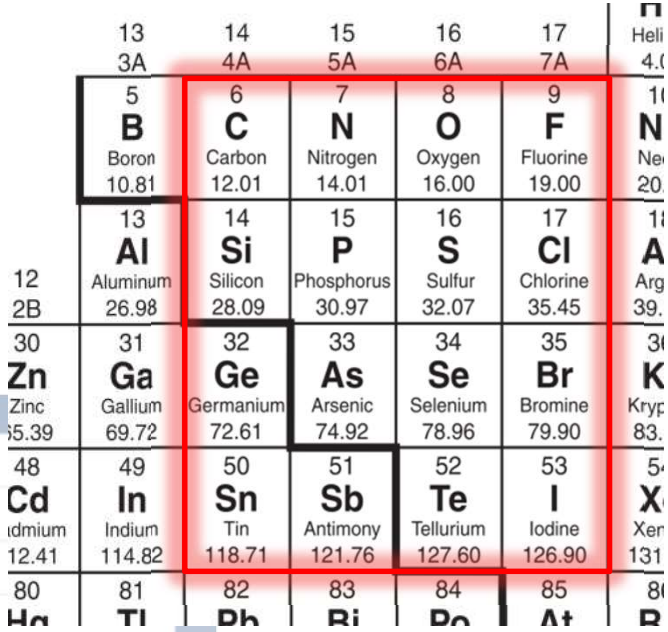


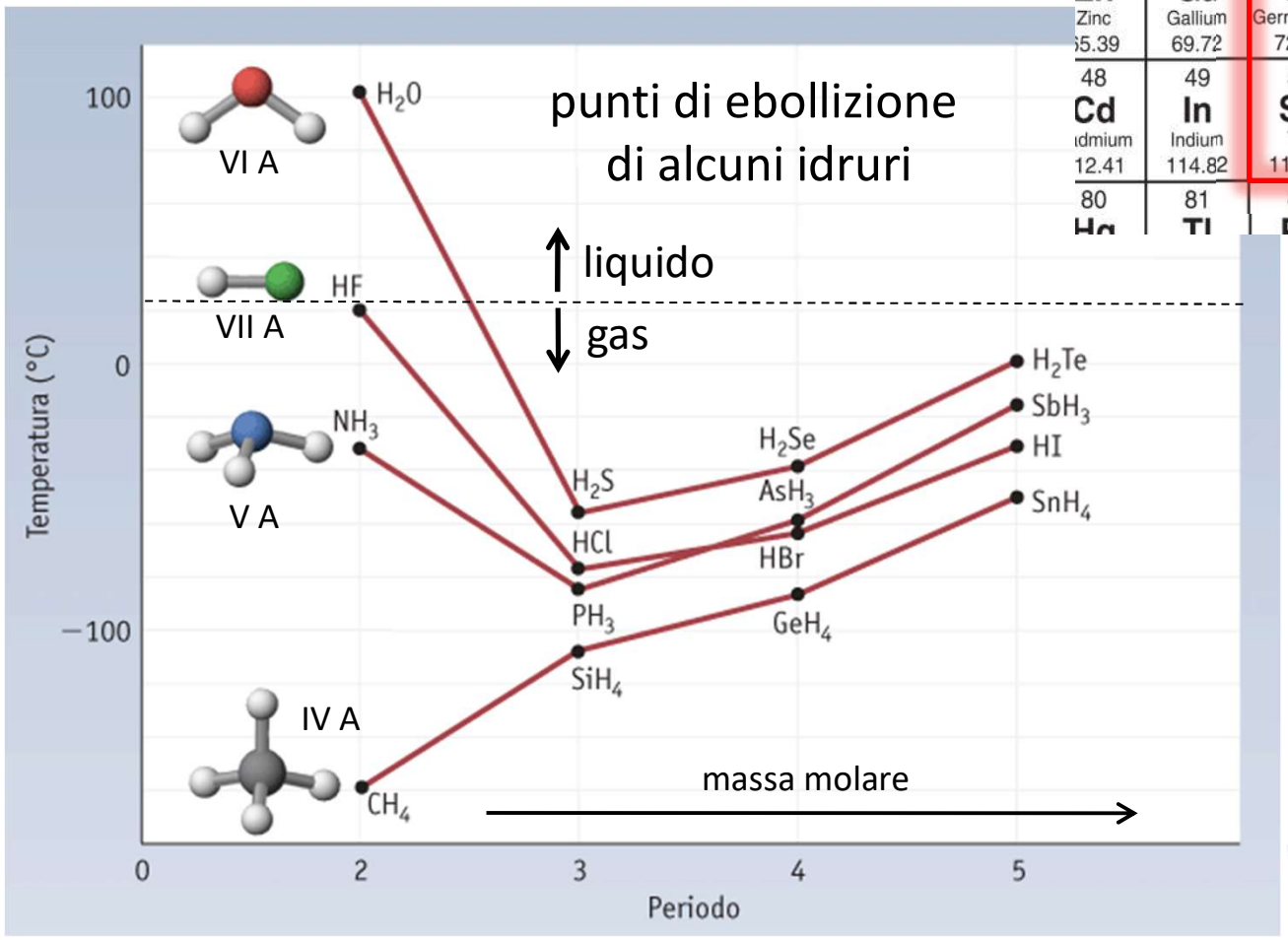
(a) Il glicole etilenico ($HOCH_2CH_2OH$), un composto polare usato come antigelo per le automobili, si scioglie in acqua.



(b) L’olio non polare per automobili (un idrocarburo) si scioglie in solventi non polari come la benzina o CCl_4. Non si scioglie, tuttavia, in un solvente polare, come l’acqua. Smacchiatori commerciali usano solventi non polari per sciogliere olio e grassi dai tessuti.



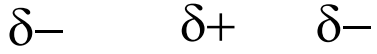

13 3A
14 4A
15 5A
16 6A
17 7A
5 B Boron 10.81
6 C Carbon 12.01
7 N Nitrogen 14.01
8 O Oxygen 16.00
9 F Fluorine 19.00
13 Al Aluminum 26.98
14 Si Silicon 28.09
15 P Phosphorus 30.97
16 S Sulfur 32.07
17 Cl Chlorine 35.45
30 Zn Zinc
31 Ga Gallium 69.72
32 Ge Germanium 72.61
33 As Arsenic 74.92
34 Se Selenium 78.96
35 Br Bromine 79.90
48 Cd
49 In Indium 114.82
50 Sn Tin 118.71
51 Sb Antimony 121.76
52 Te Tellurium 127.60
53 I Iodine 126.90
80
81 Tl
82 Pb
83 Bi
84 Po
85 At


punti di ebollizione
di alcuni idruri
liquido
gas
VI A
VII A
V A
IV A
H_2O
HF
NH_3
CH_4
H_2S
HCl
PH_3
SiH_4
H_2Se
AsH_3
HBr
GeH_4
H_2Te
SbH_3
HI
SnH_4
massa molare
Temperatura (°C)
100
0
−100
0
2
3
4
5
Periodo

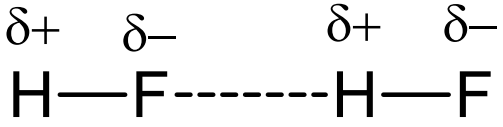

metano

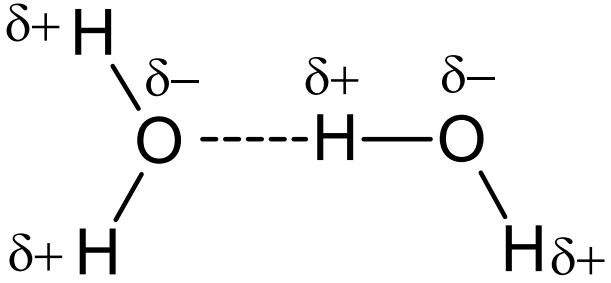
legame a idrogeno (5-40 kJ/mol)

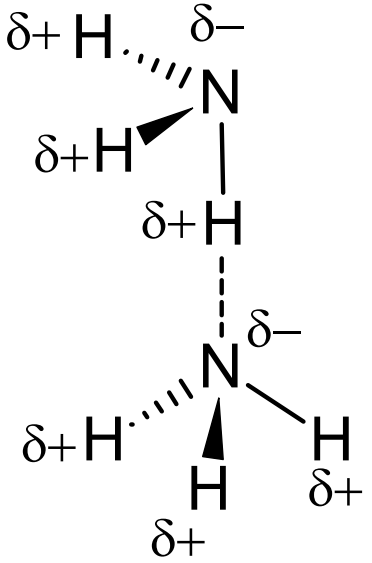
forma di interazione elettrostatica tra un atomo elettronegativo ed uno di H, legato ad un secondo atomo relativamente elettronegativo *(IUPAC)*

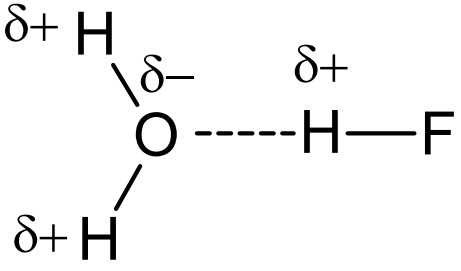


X,Y: N, O, F



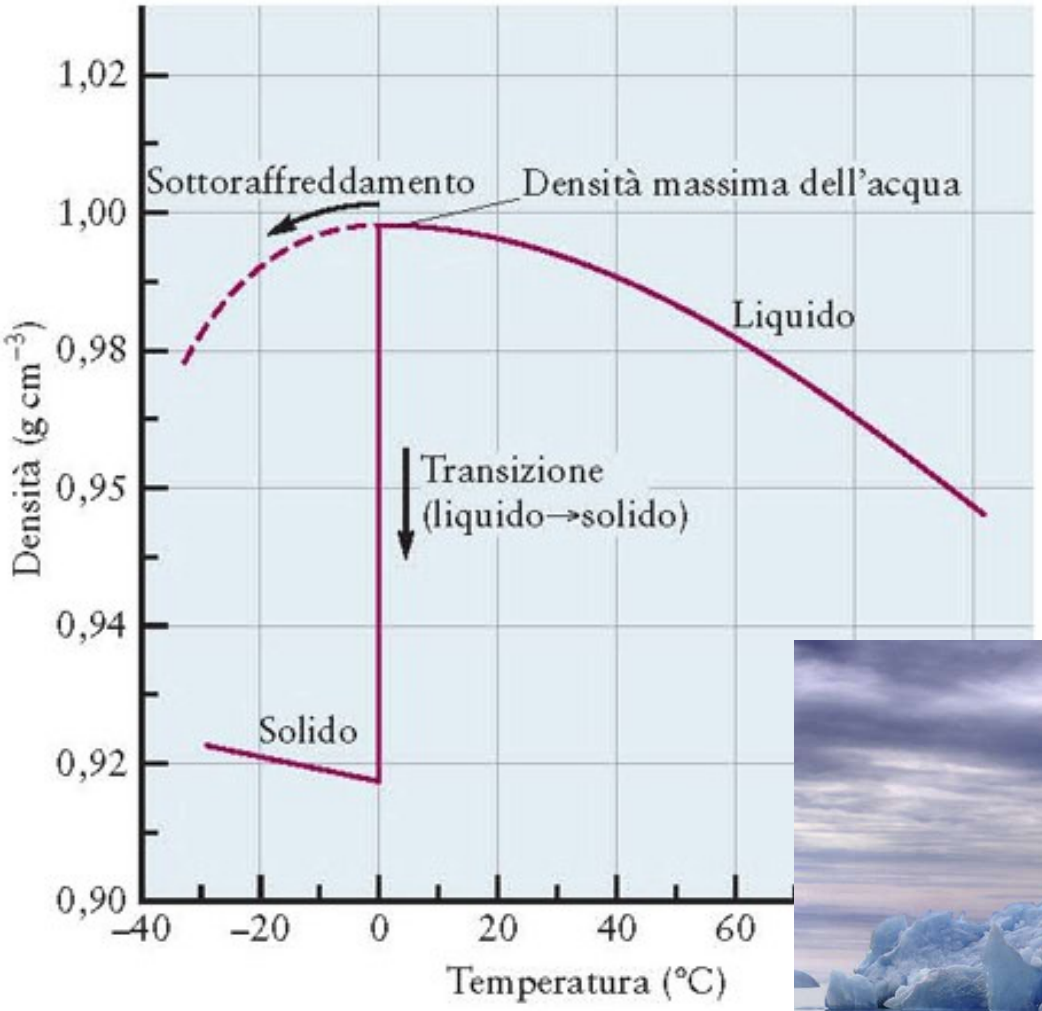


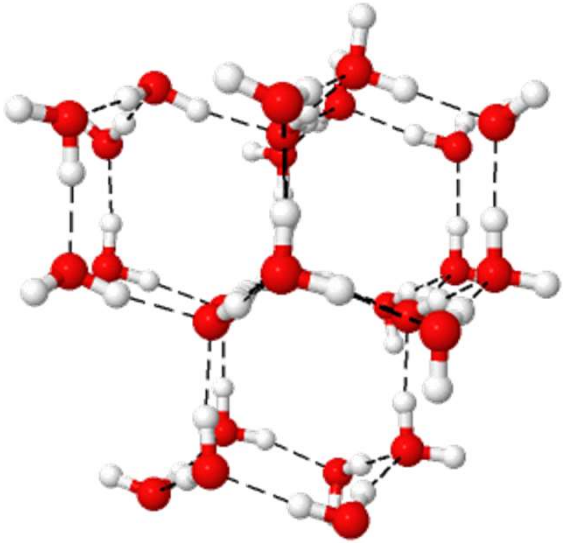


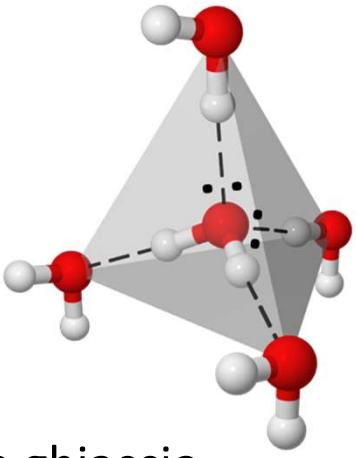


differenza con altre interazioni

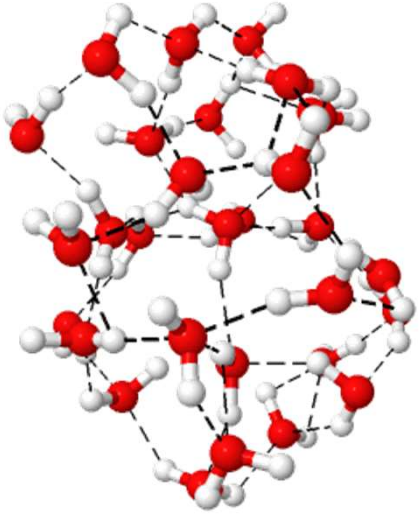
altamente direzionale


1,02
1,00
0,98
0,95
0,94
0,92
0,90
Densità (g cm^{-3})
Sottoraffreddamento
Densità massima dell'acqua
Liquido
Transizione
(liquido→solido)
Solido
–40
–20
0
20
40
60
Temperatura (°C)

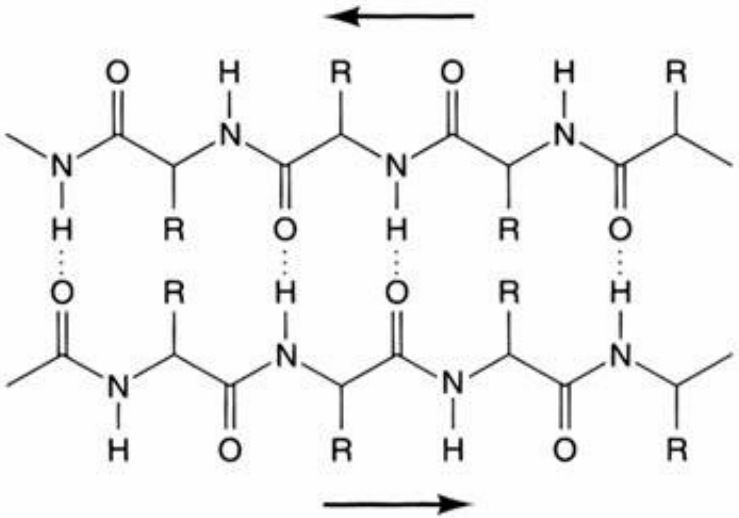




struttura ghiaccio
(ordinata)



struttura acqua liquida
(disordinata)



kevlar

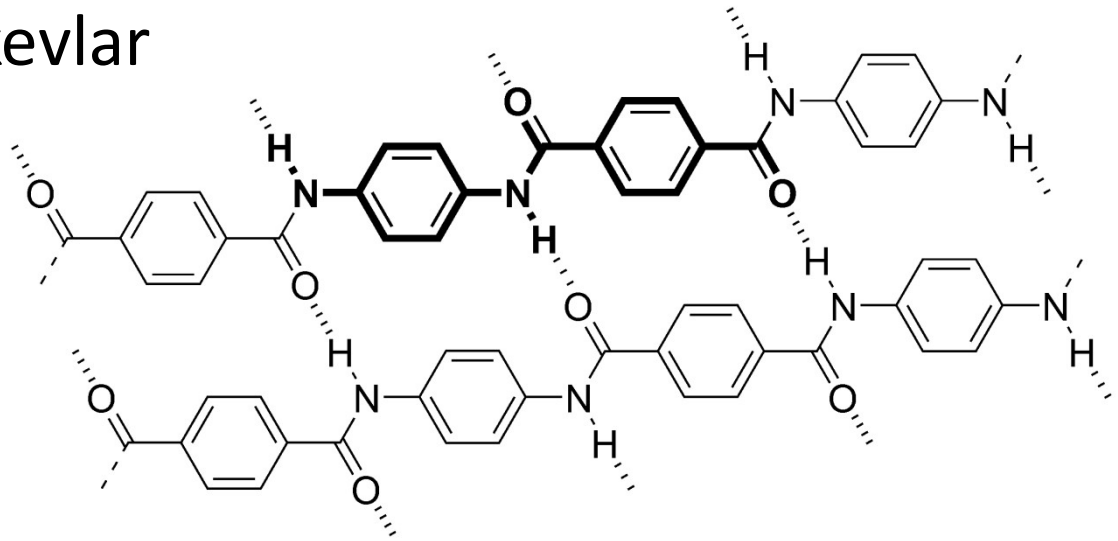
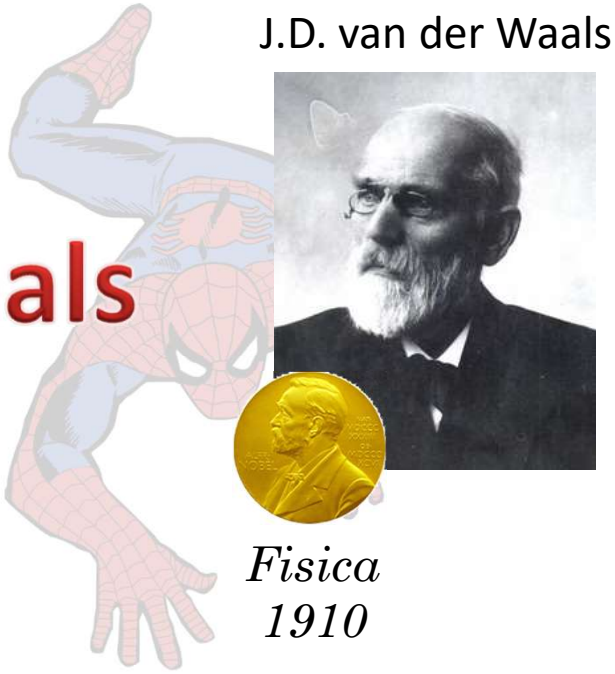


TABELLA 12.5 Riassunto delle forze intermolecolari

Tipi di interazioni	Fattori responsabili dell'interazione	Energia approssimata (kJ/mol)	Esempio
Ione-dipolo	Carica ionica, grandezza del dipolo	40–600	$Na^+ \ldots H_2O$
Dipolo-dipolo	Momento di dipolo (dipende dalle elettronegatività degli atomi e dalla struttura molecolare)	20–30	$H_2O \ldots CH_3OH$
Legame a idrogeno, X—H . . . :Y	Legame X—H molto polare (dove X = F, N, O) e atomo Y con coppia di elettroni solitari	5–30	$H_2O \ldots H_2O$
Dipolo/dipolo indotto	Momento di dipolo di molecola polare e polarizzabilità di molecola non polare	2–10	$H_2O \ldots I_2$
Dipolo indotto/dipolo indotto (forze di dispersioni di London)	Polarizzabilità	0.05–40	$I_2 \ldots I_2$

forze di van der Waals



J.D. van der Waals

Fisica
1910